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ORIGINAL RESEARCH

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Parental depressive symptoms as a family psychosocial marker for dental cooperation and visit-pattern difficulties in pediatric dentistry

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Abstract

Background: Parental depressive symptoms may be related to children's dental cooperation and continuity of care, but their role in pediatric dental visit patterns and treatment burden remains unclear. This study evaluated whether maternal and paternal depressive symptoms were associated with dental cooperation, visit-pattern difficulty, referral characteristics, and treatment outcomes. **Methods**: This retrospective observational study reviewed pediatric dental records and parental Beck Depression Inventory (BDI) assessments from a tertiary pediatric dental clinic. To reduce temporal ambiguity, only BDI assessments completed at the child's first dental visit or within 3 months before the initiation of dental treatment were included. Maternal and paternal BDI scores were analyzed separately, with BDI scores of $\geq$20 indicating elevated depressive symptoms. **Results**: Maternal BDI data were available for 300 mothers and paternal BDI data for 264 fathers. Maternal BDI $\geq$20 was associated with at least one missed or rescheduled visit $\geq$1 (odds ratio (OR) 2.91, $p = 0.021$), unplanned loss to follow-up (OR 3.57, $p = 0.003$), examination-oriented visits (OR 2.74, $p < 0.001$), and referral from pediatrics (OR 3.34, $p < 0.001$). We also observed an association with negative dental cooperation (OR 2.13, $p = 0.030$). Paternal BDI $\geq$20 was not significantly associated with these variables. Neither maternal nor paternal BDI status was directly associated with dental treatment outcomes, including sedation or treatment under general anesthesia. Cooperation and visit-pattern difficulties were associated with greater treatment burden, including sedation and/or general anesthesia, restorative treatment, and pulp therapy. **Conclusions**: Maternal depressive symptoms were associated primarily with dental visit-pattern and care-navigation difficulties, rather than with dental treatment outcomes themselves. Maternal BDI may serve as a family psychosocial marker for identifying children who could benefit from enhanced behavior guidance, appointment-navigation support, and coordinated pediatric dental care.

Keywords

Beck Depression Inventory; Parental depressive symptoms; Pediatric dentistry; Dental cooperation; Dental visit pattern; Treatment burden

1. Introduction

Successful pediatric dental care requires disease control, child cooperation, and continuity of attendance. Children who are unable to cooperate during examination or treatment may experience delayed care, incomplete procedures, or the need for pharmacologic behavior management [1, 2]. Similarly, missed appointments, repeated rescheduling, and unplanned interruption of follow-up can make routine prevention and timely operative treatment difficult [3–5]. These features are part of the clinical process of pediatric dentistry and may affect the treatment burden required to complete care.

Parental factors are particularly relevant in pediatric dentistry because parents decide when to seek care, maintain appointments, interpret treatment recommendations, and support children during stressful procedures. Previous studies have shown that parental dental fear is related to child dental fear [6]. Maternal emotional intelligence and parenting style have also been associated with child anxiety and behavior in the dental setting [7]. Parenting style has also been associated with child dental behavior and caries status [8].

A smaller body of literature has addressed broader parental psychosocial burden and children's dental service use. Maternal mental health has been identified as a potential determinant of children's oral health, and psychosocial factors in families of children with special health care needs have been associated

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with unmet dental needs and preventive dental care use [9–11]. Studies of dental attendance also suggest that family-level barriers can influence whether children receive timely preventive and restorative care [12–15]. However, these studies have generally focused on dental anxiety, parenting stress, access to care, or caries experience rather than depressive symptoms measured in both mothers and fathers during the pediatric dental care episode.

Parental depressive symptoms may influence pediatric dental care through several plausible mechanisms. Depressive symptoms can reduce energy, planning capacity, and consistency in maintaining healthcare routines. They may also affect parent-child interaction, the parent's ability to regulate the child's distress, and the clarity of communication with dental providers. Among medically complex children, these challenges may be amplified by repeated medical appointments, interdepartmental referrals, and the need to coordinate dental care with broader medical management.

The Beck Depression Inventory (BDI) provides a standardized measure of depressive symptoms. BDI scores can be categorized as normal (0–13), mild (14–19), moderate (20–28), and severe (≥29) [16, 17]. In dental research, BDI scores should not be interpreted as psychiatric diagnoses, but they may identify families experiencing psychological burden during the period in which pediatric dental care is planned and delivered. Because a cutoff of 20 corresponds to the lower threshold for the moderate range, BDI ≥20 was selected a priori to identify parents with a clinically meaningful burden of depressive symptoms.

To our knowledge, no previous pediatric dental study has simultaneously evaluated maternal and paternal BDI scores in relation to child dental cooperation, visit-pattern difficulty, referral pathway, and dental treatment outcomes. We hypothesized that parental depressive symptoms, particularly maternal BDI ≥20, would be associated with poorer child cooperation and greater difficulties in dental visit patterns. We further hypothesized that parental BDI would be more closely related to the process of dental care than directly to treatment outcomes, and that dental cooperation/visit-pattern difficulties would be associated with greater treatment burden.

2. Materials and methods

2.1 Study design and participants

This retrospective observational study was conducted at the Department of Pediatric Dentistry, Yonsei University Dental Hospital, Seoul, Republic of Korea. Children were considered eligible if a parental BDI assessment that was temporally linked to a pediatric dental care episode was available between June 2022 and October 2025. For eligible children, electronic dental records were reviewed from the first recorded pediatric dental visit to the last recorded follow-up visit to characterize the duration of available dental follow-up, visit patterns, referral characteristics, and treatment history. The overall observation window was used to describe follow-up duration and the number of potential visit opportunities, whereas the temporal eligibility of the BDI assessment and the ascertainment of dental treatment outcomes were defined in relation to the indexed dental care episode.

Children were eligible when temporally eligible maternal and/or paternal BDI data were available and pediatric dental records contained information required to evaluate dental cooperation, visit patterns, referral sources, visit reason, and treatment history. Cases with missing data for a specific variable were excluded from the corresponding analysis but retained in analyses for which the required data were available. The study was approved by the Institutional Review Board of Yonsei University Dental Hospital (IRB Approval No. 2-2025-0060), and the requirement for informed consent was waived because of the retrospective design. All the collected data were anonymized before analysis.

2.2 Assessment of parental depressive symptoms

Parental depressive symptoms were assessed using the BDI. Maternal and paternal BDI scores were analyzed separately because maternal and paternal psychological burden may relate differently to pediatric dental attendance and treatment processes. The timing of each parental BDI assessment was verified using the questionnaire completion date recorded in the study database and cross-checked with the electronic dental record.

To reduce temporal ambiguity, we included only BDI assessments completed at the initial visit of the indexed dental care episode or within 3 months before the initiation of active dental treatment. The indexed dental care episode was defined as the episode of pediatric dental evaluation and treatment to which the parental BDI assessment was temporally linked. Initiation of active dental treatment was defined as the first visit after the initial examination and treatment planning at which preventive treatment, operative treatment, pharmacologic behavior management, or treatment under general anesthesia was performed. BDI assessments outside this predefined temporal window were not included in the analysis.

BDI scores were first classified into four conventional severity categories: normal (0–13), mild (14–19), moderate (20–28), and severe (≥29). For the primary analysis, scores were dichotomized into BDI <20 versus BDI ≥20. This cutoff grouped the normal and mild categories and compared them with the moderate and severe categories. BDI scores were also considered as continuous variables in supplementary analyses of selected baseline characteristics. BDI scores were used as symptom indices and were not interpreted as psychiatric diagnoses. Maternal and paternal BDI assessments were evaluated independently according to the same temporal eligibility criteria; therefore, cases with eligible maternal BDI data but missing or ineligible paternal BDI data were retained for maternal analyses, and *vice versa*.

2.3 Clinical variables

Baseline variables unrelated to dental treatment included age at first dental visit, sex, gestational age <32 weeks, birth weight <1.5 kg, and only-child status. Observation characteristics included follow-up duration and the total number of dental visits. Follow-up duration was defined as the interval between the child's first and last recorded dental visits during the obser-

vation period and was presented in months. Total dental visits were defined as the number of recorded visits to the pediatric dental clinic during the same period. These variables were included to evaluate whether differences in the opportunity for observation could explain differences in visit-pattern or treatment-related outcomes.

Medical complexity variables included disability, rare disease, and the composite variable of disability or rare disease. Socioeconomic and geographic variables included receipt of medical aid, which was used as a proxy for low socioeconomic status, and residence outside the metropolitan area. Referral source was classified as no referral, referral from pediatrics, or referral from dentistry. Reason for visit was classified as examination-oriented, caries-related, or other. Referral source and reason for visit were treated as multicategory variables, and overall *p*-values were calculated across categories.

The primary outcomes of interest were dental cooperation and visit-pattern indicators (negative dental cooperation, at least one missed or rescheduled visit, and unplanned loss to follow-up), because these variables reflect core care-process difficulties that may mediate the relationship between parental depressive symptoms and treatment burden. Secondary outcomes included referral characteristics and reason for visit, and exploratory outcomes included specific dental treatment procedures and pharmacologic behavior management (treatment under sedation and/or general anesthesia).

Dental cooperation and visit-pattern variables included negative dental cooperation, at least one missed or rescheduled visit, unplanned loss to follow-up, examination-oriented visit, and referral from pediatrics. Dental cooperation during dental treatment was evaluated using the Frankl Behavior Rating Scale, which classifies behavior into four categories ranging from 1 (definitely negative) to 4 (definitely positive). For analysis, Frankl scores were dichotomized; scores of 1 and 2 were classified as negative cooperation, and scores of 3 and 4 were classified as positive cooperation. Having at least one missed or rescheduled visit indicated at least one missed or rescheduled appointment. Unplanned loss to follow-up indicated discontinuation or interruption of planned follow-up without completion of the expected care sequence.

Dental treatment outcomes included preventive care (*e.g.*, fluoride application, scaling, or sealant application), restorative dental treatment (*e.g.*, glass ionomer restoration, composite resin restoration, or stainless-steel crown placement), pulp treatment, tooth extraction, treatment under sedation, and treatment under general anesthesia. Treatment under sedation was defined as dental treatment performed under intramuscular midazolam sedation or nitrous oxide inhalation. Treatment under general anesthesia was defined as dental treatment performed under general anesthesia. For the forest plot, sedation and/or general anesthesia was used as a composite measure of pharmacologic behavior management. Advanced dental treatment burden included stainless-steel crown placement, pulp therapy, tooth extraction, and space maintainer treatment.

Dental treatment outcomes were counted only when they occurred on or after the corresponding eligible BDI assessment within the same temporally linked indexed dental care episode; dental treatments recorded before the eligible BDI assessment were not counted as treatment outcome events.

2.4 Statistical analysis

Continuous variables are presented as mean ± standard deviation, and categorical variables are presented as n (%). Follow-up duration and total dental visits are additionally presented as medians because of their skewed distributions. Comparisons between maternal BDI <20 and maternal BDI ≥ 20 groups were performed using independent-samples *t* tests or Mann-Whitney U tests for continuous variables and chi-square tests or Fisher exact tests for categorical variables, as appropriate. For referral source and reason for visit, *p*-values represent overall comparisons across categories. The correlation between maternal and paternal BDI was assessed using Spearman correlation.

Maternal and paternal BDI analyses were performed separately. Proportion of cooperation, visit-pattern, referral, and treatment outcome variables were compared between BDI <20 and BDI ≥ 20 groups. Odds ratio and 95% confidence intervals were calculated for associations between BDI ≥ 20 and cooperation or visit-pattern variables. Associations between cooperation/visit-pattern indicators and treatment-burden outcomes were summarized using unadjusted odds ratios and 95% confidence intervals. These estimates were interpreted as observed associations, not causal effects.

In the primary adjusted analyses, logistic regression models were fitted to examine associations between maternal BDI ≥ 20 and the primary care-process indicators (negative dental cooperation, at least one missed or rescheduled visit, and unplanned loss to follow-up) as well as the secondary referral- and visit-related indicators (examination-oriented visits and referral from pediatrics). Maternal BDI group (≥ 20 *vs.* <20) was entered as the main predictor. Models were adjusted for age, disability or rare disease, residence outside the metropolitan area, sex, and caries-related visit reason, as appropriate. For missed or rescheduled visits and unplanned loss to follow-up, the number of adjustment variables was restricted to age, disability or rare disease, and residence outside the metropolitan area to reduce overfitting given the limited number of events. Similar logistic regression methods were used to examine associations between cooperation/visit-pattern indicators and treatment-burden outcomes. These models were adjusted for age, disability or rare disease, caries-related visit reason, and residence outside the metropolitan area when applicable. Complete-case analyses were used for each adjusted model. Crude and adjusted odds ratios with 95% confidence intervals were summarized in **Supplementary Tables 1 and 2**.

Statistical significance was set at $p < 0.05$. Analyses were performed using IBM SPSS Statistics for Windows, version 29.0.2.0 (IBM Corp., Armonk, NY, USA). The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) framework for observational studies, as detailed in **Supplementary material 1**.

3. Results

3.1 Study population and parental BDI characteristics

The non-treatment characteristics of the study population and parental BDI concordance patterns are summarized in Table 1. Maternal BDI data were available for 300 mothers and paternal BDI data were available for 264 fathers. In total, complete BDI data for both parents were available for 260 parent-child dyads. The mean maternal and paternal BDI scores were 15.1 ± 10.1 and 9.6 ± 8.3, respectively. Among paired cases, maternal and paternal BDI scores were modestly correlated (Spearman *rho* = 0.339, $p < 0.001$). Most paired cases had both parents in the BDI <20 group (176/260, 67.7%), whereas both parents had BDI ≥20 in 16 cases (6.2%).

Child demographic and perinatal characteristics were comparable between maternal BDI groups, including age at first dental visit, sex, gestational age <32 weeks, birth weight <1.5 kg, and only-child status. Observation characteristics were also similar: follow-up duration was 41.0 ± 43.2 months in the maternal BDI <20 group and 44.3 ± 46.5 months in the maternal BDI ≥20 group ($p = 0.478$), and total dental visits were 11.4 ± 11.6 and 11.3 ± 12.1, respectively ($p = 0.926$).

In contrast, medical complexity differed by maternal BDI status. The maternal BDI ≥20 group had higher proportions of disability (36.1% *vs.* 19.4%; $p = 0.002$), rare disease (24.1% *vs.* 8.3%; $p < 0.001$), and disability or rare disease (45.8% *vs.* 24.4%; $p < 0.001$). Residence outside the metropolitan area was also more frequent in the maternal BDI ≥20 group (51.8% *vs.* 37.3%; $p = 0.023$), whereas medical aid or low socioeconomic proxy did not differ. Referral source and reason for visit differed between groups: referral from pediatrics (25.3% *vs.* 9.2%; overall $p < 0.001$) and examination-oriented visits (33.7% *vs.* 15.7%; overall $p = 0.002$) were more common in the maternal BDI ≥20 group.

3.2 Parental BDI status, dental cooperation, visit patterns, and treatment outcomes

Fig. 1 summarizes dental cooperation, visit-pattern variables, and dental treatment outcomes according to maternal and paternal BDI status. Compared with maternal BDI <20, maternal BDI ≥20 was associated with a higher proportion of negative dental cooperation (72.7% *vs.* 55.6%; OR 2.13, 95% confidence interval (CI) 1.08–4.20; $p = 0.030$), missed or rescheduled visit ≥1 (91.9% *vs.* 79.6%; OR 2.91, 95% CI 1.17–7.23; $p = 0.021$), unplanned loss to follow-up (81.8% *vs.* 55.7%; OR 3.57, 95% CI 1.53–8.32; $p = 0.003$), examination-oriented visits (33.7% *vs.* 15.7%; OR 2.74, 95% CI 1.53–4.91; $p < 0.001$), and referral from pediatrics (25.3% *vs.* 9.2%; OR 3.34, 95% CI 1.70–6.56; $p < 0.001$).

In contrast, paternal BDI ≥20 was not statistically significantly associated with any of the cooperation or visit-pattern variables: negative dental cooperation (68.2% *vs.* 59.4%; OR 1.46, 95% CI 0.56–3.81; $p = 0.437$), missed or rescheduled visit ≥1 (85.2% *vs.* 81.0%; OR 1.35, 95% CI 0.44–4.13; $p = 0.603$), unplanned loss to follow-up (72.2% *vs.* 58.4%; OR 1.85, 95% CI 0.62–5.51; $p = 0.268$), examination-oriented visit (30.3% *vs.* 21.2%; OR 1.61, 95% CI 0.72–3.62; $p = 0.244$), and referral from pediatrics (15.2% *vs.* 12.6%; OR 1.24, 95% CI 0.44–3.48; $p = 0.677$).

Dental treatment outcomes did not differ significantly according to either maternal or paternal BDI status. In the maternal BDI ≥20 and <20 groups, the corresponding proportions were 71.1% versus 63.1% for preventive care ($p = 0.196$), 56.6% versus 54.8% for restorative dental treatment ($p = 0.781$), 30.1% versus 28.1% for pulp treatment ($p = 0.731$), 10.8% versus 13.4% for extraction ($p = 0.557$), 16.9% versus 14.7% for treatment under sedation ($p = 0.648$), and 12.0% versus 6.5% for treatment under general anesthesia ($p = 0.110$). In the paternal BDI ≥20 and <20 groups, the corresponding proportions were 75.8% versus 64.5% for preventive care ($p = 0.202$), 48.5% versus 52.8% for restorative dental treatment ($p = 0.641$), 27.3% versus 26.0% for pulp treatment ($p = 0.874$), 18.2% versus 11.7% for extraction ($p = 0.291$), 12.1% versus 14.3% for treatment under sedation ($p = 1.000$), and 6.1% versus 6.9% for treatment under general anesthesia ($p = 1.000$).

Taken together, Fig. 1 shows that elevated maternal BDI was associated with cooperation and visit-pattern difficulties, but not with treatment outcomes directly. This pattern was not explained by longer follow-up duration or more frequent dental visits in the maternal BDI ≥20 group, as shown in Table 1.

As shown in **Supplementary Table 1**, maternal BDI ≥20 showed significant crude associations with all care-process indicators. After adjustment for age, disability or rare disease, residence outside the metropolitan area, sex, and caries-related visit reason, the association with negative dental cooperation was attenuated and no longer statistically significant (crude OR 2.13, 95% CI 1.08–4.20, $p = 0.030$; adjusted OR 1.71, 95% CI 0.75–3.91, $p = 0.21$). In contrast, the associations with missed or rescheduled visits (adjusted OR 2.85, 95% CI 1.13–7.21, $p = 0.027$), unplanned loss to follow-up (adjusted OR 3.36, 95% CI 1.41–8.00, $p = 0.006$), examination-oriented visits (adjusted OR 2.43, 95% CI 1.21–4.88, $p = 0.013$), and referrals from pediatrics remained significant (adjusted OR 2.19, 95% CI 1.05–4.57, $p = 0.037$).

3.3 Cooperation and visit-pattern indicators in relation to treatment burden

Although parental BDI status was not directly associated with treatment outcomes, cooperation and visit-pattern indicators were associated with treatment burden in unadjusted analyses (Fig. 2). Negative dental cooperation was associated with higher odds of treatment under sedation and/or general anesthesia (OR 4.69, 95% CI 2.17–10.15; $p < 0.001$) and advanced dental treatment burden (OR 1.94, 95% CI 1.08–3.48; $p = 0.029$). Unplanned loss to follow-up was associated with higher odds of restorative dental treatment (OR 4.61, 95% CI 2.23–9.54; $p < 0.001$) and treatment under sedation and/or general anesthesia (OR 4.33, 95% CI 1.33–14.04; $p = 0.006$). Missed or rescheduled visit ≥1 was associated with higher odds of pulp therapy (OR 2.87, 95% CI 1.25–6.60; $p = 0.008$) and restorative dental treatment (OR 2.43, 95% CI 1.26–4.69; $p = 0.009$).

Children with multiple cooperation/visit-pattern difficulties, defined as two or more indicators among negative dental cooperation, missed or rescheduled visit ≥1, and unplanned loss to follow-up, had higher odds of sedation and/or general anesthesia (OR 3.14, 95% CI 1.75–5.66; $p < 0.001$), restorative

TABLE 1. Parental BDI concordance and non-treatment characteristics of the study population.

Characteristic	Overall	Maternal BDI <20 (n = 217)	Maternal BDI ≥20 (n = 83)	*p*-value
Parental BDI characteristics				
Maternal BDI score	15.1 ± 10.1	10.0 ± 5.0	28.4 ± 7.4	N/A
Paternal BDI score	9.6 ± 8.3	8.4 ± 7.5	13.3 ± 9.3	<0.001
Paternal BDI ≥20	33 (12.5)	17 (7.8)	16 (19.3)	0.005
Maternal-paternal BDI correlation		*rho* = 0.339; $p < 0.001$; n = 260		
Parental BDI concordance pattern				
Both parents BDI <20	176 (67.7)	176 (91.2)	0 (0.0)	
Maternal BDI ≥20 only	51 (19.6)	0 (0.0)	51 (76.1)	
Paternal BDI ≥20 only	17 (6.5)	17 (8.8)	0 (0.0)	
Both parents BDI ≥20	16 (6.2)	0 (0.0)	16 (23.9)	
Child and family non-treatment characteristics				
Age at first dental visit, yr	5.1 ± 3.2	5.1 ± 3.1	5.1 ± 3.4	0.802
Male sex	204 (68.0)	147 (67.7)	57 (68.7)	0.877
Gestational age <32 wk	11 (3.7)	7 (3.2)	4 (4.8)	0.511
Birth weight <1.5 kg	11 (3.7)	8 (3.7)	3 (3.6)	0.976
Only child status	147 (49.0)	111 (51.2)	36 (43.4)	0.228
Observation characteristics				
Follow-up duration (mon)	41.9 ± 44.1	41.0 ± 43.2	44.3 ± 46.5	0.478
Follow-up duration, median	30.9	30.8	31.0	
Total dental visits	11.3 ± 11.7	11.4 ± 11.6	11.3 ± 12.1	0.926
Total dental visits, median	8	8	7	
Medical complexity				
Disability	72 (24.0)	42 (19.4)	30 (36.1)	0.002
Rare disease	38 (12.7)	18 (8.3)	20 (24.1)	<0.001
Disability or rare disease	91 (30.3)	53 (24.4)	38 (45.8)	<0.001
Socioeconomic/geographic characteristics				
Medical aid or low socioeconomic proxy	15 (5.0)	9 (4.1)	6 (7.2)	0.273
Residence outside metropolitan area	124 (41.3)	81 (37.3)	43 (51.8)	0.023
Referral source				
No referral	238 (79.3)	179 (82.5)	59 (71.1)	
Referral from pediatrics	41 (13.7)	20 (9.2)	21 (25.3)	<0.001
Referral from dentistry	21 (7.0)	18 (8.3)	3 (3.6)	
Reason for visit				
Examination-oriented visit	62 (20.7)	34 (15.7)	28 (33.7)	
Caries-related visit	105 (35.0)	80 (36.9)	25 (30.1)	0.002
Other visit reasons	133 (44.3)	103 (47.5)	30 (36.1)	

Values are presented as mean ± standard deviation or n (%), unless otherwise indicated. BDI, Beck Depression Inventory; N/A, not applicable. p-values compare maternal BDI <20 and maternal BDI ≥20 groups. For referral source and visit reason, p values indicate the overall comparison across categories. Maternal-paternal BDI correlation was calculated among cases with paired maternal and paternal BDI scores. Paternal BDI data were available for 264 fathers. Maternal-paternal BDI correlation was calculated among 260 paired parent-child dyads.

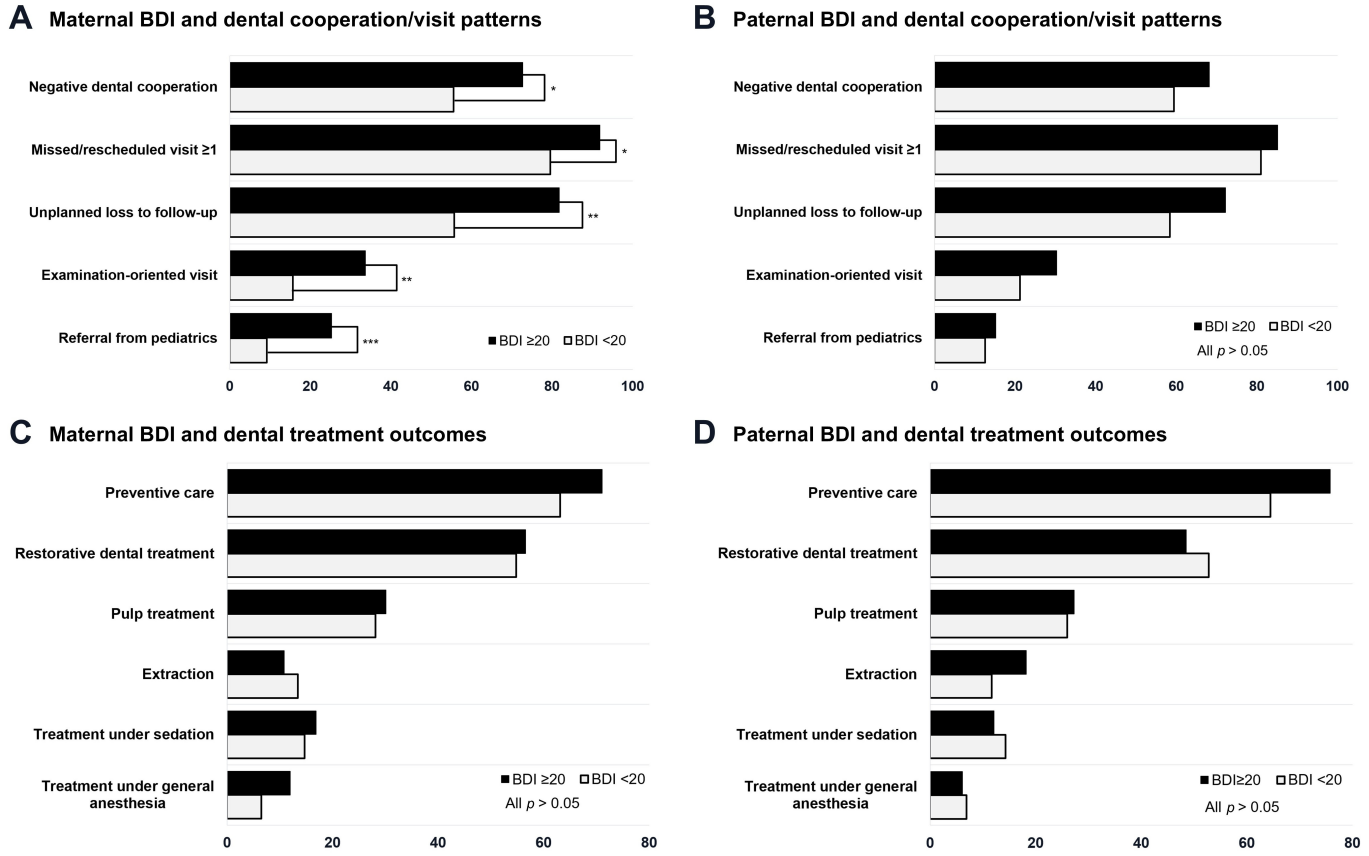


FIGURE 1. Dental cooperation, visit patterns, and treatment outcomes according to parental BDI status. (A) Dental cooperation and visit-pattern variables according to maternal BDI status. (B) Dental cooperation and visit-pattern variables according to paternal BDI status. (C) Dental treatment outcomes according to maternal BDI status. (D) Dental treatment outcomes according to paternal BDI status. Patients were classified according to maternal or paternal BDI scores using a cutoff of 20. Black bars represent BDI ≥20 and white bars represent BDI <20. Maternal BDI ≥20 was significantly associated with negative dental cooperation, missed or rescheduled visits, unplanned loss to follow-up, examination-oriented visits, and referrals from pediatrics. In contrast, paternal BDI ≥20 showed no significant associations with these variables. Dental treatment outcomes did not differ significantly according to maternal or paternal BDI status. Sedation was defined as MIDA or nitrous oxide use. Values are percentages. BDI, Beck Depression Inventory; MIDA, midazolam. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

dental treatment (OR 2.53, 95% CI 1.59–4.02; $p < 0.001$), and pulp therapy (OR 1.95, 95% CI 1.18–3.23; $p = 0.011$). Caries-related visit reason was strongly associated with pulp therapy (OR 6.93, 95% CI 4.02–11.96; $p < 0.001$), restorative dental treatment (OR 5.39, 95% CI 3.11–9.34; $p < 0.001$), and sedation and/or general anesthesia (OR 4.92, 95% CI 2.76–8.78; $p < 0.001$), providing clinical context for the treatment burden observed in children with care-process difficulties.

In adjusted sensitivity analyses, several key associations remained significant after accounting for age, disability or rare disease, caries-related visit reason, and residence outside the metropolitan area, as applicable (**Supplementary Table 2**). Negative dental cooperation remained associated with sedation and/or general anesthesia (adjusted OR 3.10, 95% CI 1.29–7.50; $p = 0.012$). Unplanned loss to follow-up remained associated with restorative dental treatment (adjusted OR 3.97, 95% CI 1.80–8.78; $p < 0.001$), whereas its association with sedation and/or general anesthesia was attenuated and no longer statistically significant after adjustment (adjusted OR 2.67, 95% CI 0.71–10.05; $p = 0.147$). Multiple cooperation/visit-pattern difficulties remained associated with sedation and/or general anesthesia (adjusted OR 2.47, 95% CI 1.29–4.72; $p = 0.006$) and restorative dental treatment (adjusted OR 2.04, 95% CI 1.23–3.38; $p = 0.006$), but not with pulp therapy after adjustment (adjusted OR 1.49, 95% CI 0.84–2.66; $p = 0.172$).

Fig. 3 provides a conceptual summary of the observed associations. Maternal depressive symptoms were associated with limited cooperation and dental visit-pattern difficulty, while these care-process difficulties were linked to pharmacologic behavior management and operative treatment burden. Direct associations between parental BDI status and treatment outcomes were not statistically significant. The adjusted sensitivity analyses support the robustness of selected care-process-to-treatment-burden associations, particularly for sedation and/or general anesthesia and restorative dental treatment.

4. Discussion

This study found that elevated maternal depressive symptoms were associated with several indicators of difficulties in the pediatric dental care process, particularly missed or rescheduled visits, unplanned loss to follow-up, examination-oriented

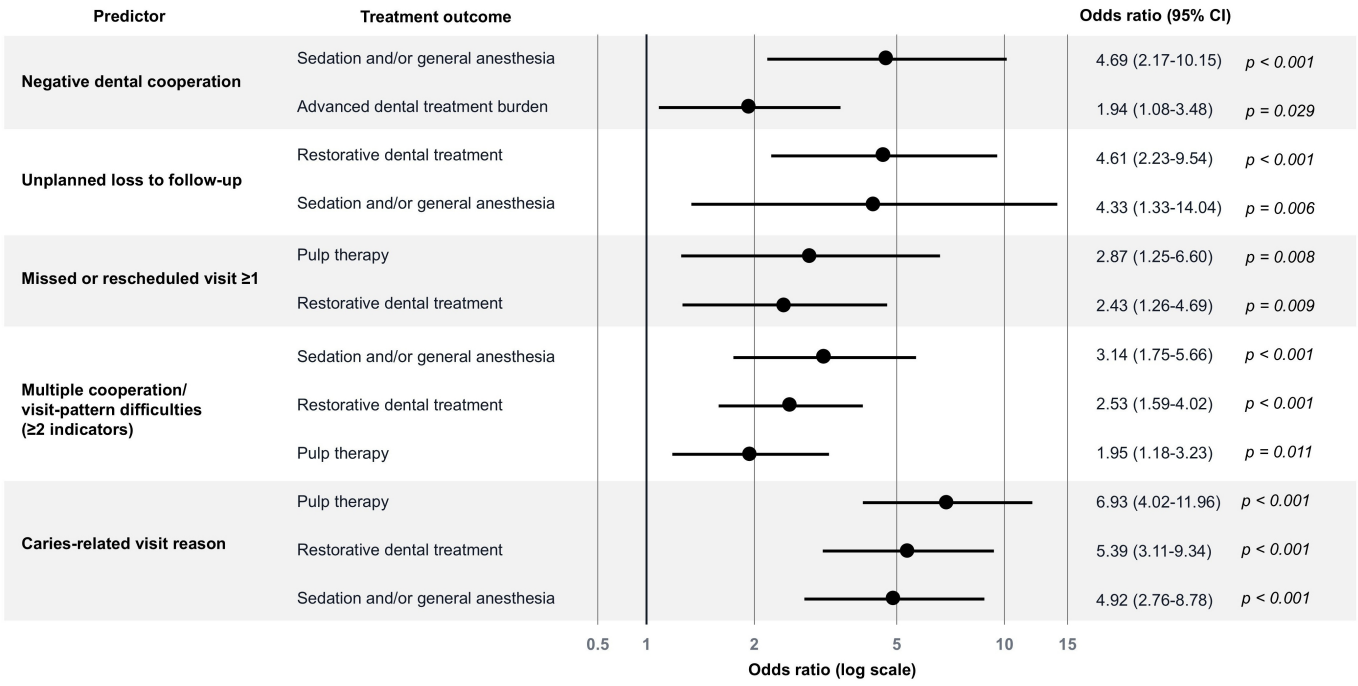


FIGURE 2. Associations between dental cooperation/visit-pattern difficulties and pediatric dental treatment burden. Forest plot showing unadjusted odds ratios and 95% confidence intervals for the associations between dental cooperation/visit-pattern indicators and treatment outcomes. Odds ratios greater than 1 indicate higher odds of each treatment outcome among patients with the corresponding indicator. Multiple cooperation/visit-pattern difficulties (≥2 indicators) were defined as the presence of two or more of the following: negative dental cooperation, missed or rescheduled visit ≥1, and unplanned loss to follow-up. Sedation and/or general anesthesia included treatment under sedation or general anesthesia. Advanced dental treatment burden included stainless-steel crown placement, pulp therapy, tooth extraction, and space maintainer treatment. Odds ratios are plotted on a logarithmic scale.

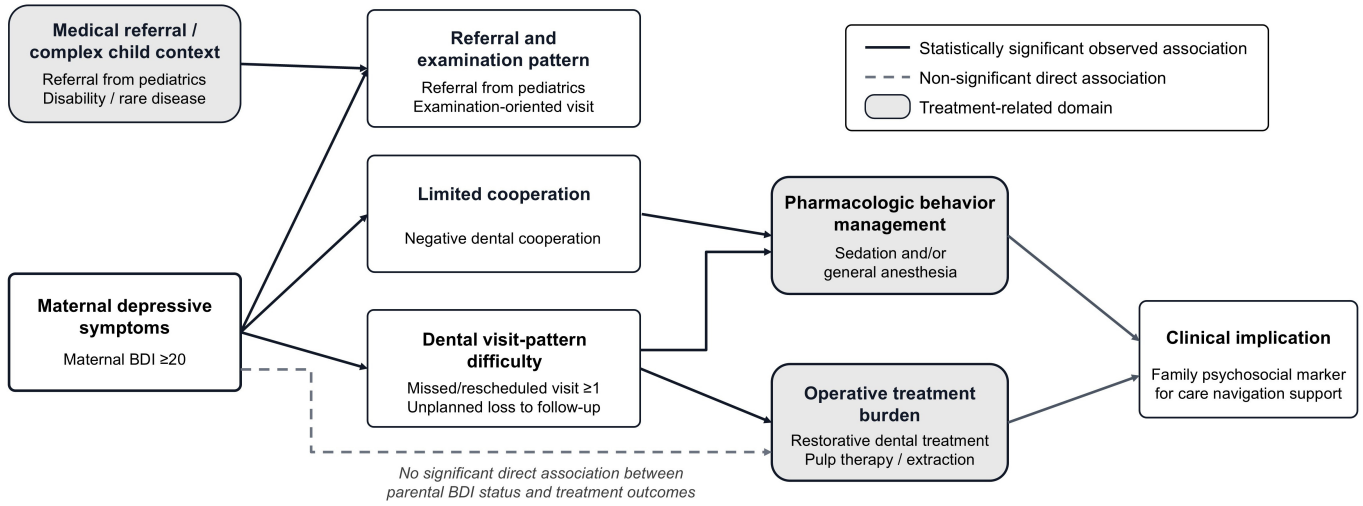


FIGURE 3. Conceptual summary of observed associations in pediatric dental care. Maternal BDI ≥20 was associated with several care-process indicators, particularly dental visit-pattern difficulty, including missed or rescheduled visits and unplanned loss to follow-up. An unadjusted association with limited dental cooperation was also observed, but this relationship should be interpreted with caution because cooperation may be influenced by the child's medical complexity and other clinical factors. Cooperation and visit-pattern difficulties were associated with pharmacologic behavior management and operative treatment burden. Direct associations between parental BDI status and treatment outcomes were not statistically significant. Solid arrows indicate statistically significant observed associations, dashed arrows indicate non-significant direct associations, and shaded boxes indicate treatment-related domains. Arrows indicate associations and do not imply causality. BDI, Beck Depression Inventory.

visits, and referral from pediatrics. Maternal BDI ≥20 was also associated with negative dental cooperation in unadjusted analyses; however, this association should be interpreted cautiously because child medical complexity and related clinical factors may contribute to cooperation difficulties. In contrast, paternal BDI ≥20 was not significantly associated with these care-process variables. Neither maternal nor paternal BDI status was directly associated with dental treatment outcomes, including preventive care, restorative treatment, pulp therapy, extraction, sedation, or treatment under general anesthesia.

The central interpretation of these findings is that parental depressive symptoms may be more closely related to how pediatric dental care is accessed, maintained, and completed than to the need for operative treatment itself [9, 11]. The absence of significant direct associations between parental BDI status and treatment outcomes argues against a simplified interpretation that parental depressive symptoms lead to more invasive dental treatment. Instead, the findings suggest a more cautious clinical model: elevated maternal BDI may indicate a family-care context in which appointment continuity, care navigation, and, potentially child cooperation are more vulnerable. These care-process difficulties were, in turn, associated with treatment burden, although the present study cannot determine the temporal or causal relationships among parental depressive symptoms, care-process difficulties, and treatment outcomes.

Several mechanisms may explain why maternal depressive symptoms could be associated with difficulties in maintaining pediatric dental care. Depressive symptoms may reduce the caregiver's capacity for planning, appointment adherence, and sustained follow-up. Pediatric dental care often requires repeated visits, preparation before appointments, decision-making about treatment options, and consistent caregiver engagement [18]. These demands may be more challenging for caregivers experiencing depressive symptoms or broader psychosocial strain. Depressive symptoms may also influence parent-child interactions and caregivers' ability to help regulate child distress during dental visits. However, this interpretation should be cautious because dental cooperation is multifactorial and may be influenced by child-related and clinical factors. Accordingly, the observed association between maternal BDI and negative cooperation in unadjusted analyses should not be interpreted as a direct maternal effect on child behavior.

Caregiver depressive symptoms are only one aspect of family psychological burden. Caregiver anxiety and parenting stress may also affect dental attendance, communication, and the ability to manage complex treatment plans, whereas resilience and social support may help families maintain continuity of care despite these challenges. Future studies should assess these related constructs concurrently to clarify their independent and combined contributions to pediatric dental care.

The association between elevated maternal BDI and pediatric referral, as well as higher proportions of disability and rare disease, suggests that maternal depressive symptoms may partly reflect the burden of caring for a medically complex child. Families referred by pediatrics may already be engaged in ongoing medical care, repeated hospital visits, and multidisciplinary coordination before dental treatment begins. In this context, maternal BDI may capture accumulated caregiver strain during the same period in which dental care is initiated. This interpretation is supported by the higher proportions of disability, rare disease, pediatric referral, and examination-oriented visits in the maternal BDI ≥20 group. At the same time, this pattern also raises an important confounding concern: medically complex child status may contribute both to higher maternal BDI scores and to more difficult dental care processes [19, 20]. Therefore, maternal BDI should be interpreted as a family psychosocial marker within a medically complex care context, not as an isolated causal exposure [10]. The additional adjusted analyses further clarify the role of child factors in the observed cooperation difficulties. The unadjusted association between maternal BDI ≥20 and negative dental cooperation became non-significant after adjustment for age, disability or rare disease, residence, sex, and caries-related visit reason, whereas child disability or rare disease remained strongly associated with negative cooperation. This pattern suggests that child age and medical complexity are primary drivers of cooperation problems, and that the apparent maternal BDI–cooperation relationship in unadjusted analyses likely reflects confounding by child-related factors rather than an independent maternal effect [11, 21, 22].

In contrast, maternal BDI ≥20 remained significantly associated with missed or rescheduled visits, unplanned loss to follow-up, examination-oriented visits, and referrals from pediatrics even after adjustment for key child and family covariates. These adjusted associations support the interpretation that maternal depressive symptoms are linked to appointment instability and care-navigation difficulties beyond what can be explained by child medical complexity, age, or geographic access alone [23]. Nevertheless, the observational design precludes causal inference, and maternal BDI should be interpreted as a contextual family psychosocial marker rather than a definitive causal exposure.

Paternal findings also require caution. Maternal and paternal BDI scores were modestly correlated, suggesting some degree of shared family-level psychological burden. However, paternal BDI ≥20 was not significantly associated with dental cooperation, visit patterns, or treatment outcomes. This pattern may reflect differences in how maternal and paternal depressive symptoms relate to pediatric dental care, but it may also be influenced by differences in caregiver roles involvement in dental care, and measurement limitations. In many pediatric dental settings, mothers may more often schedule visits, communicate with providers, and accompany the child to treatment. As a result, maternal psychological burden may be more visible in dental attendance and cooperation records, whereas paternal burden may be less directly captured. In addition, paternal BDI data were less complete, and fewer fathers had BDI ≥20, limiting statistical power.

The treatment-related findings help clarify the clinical relevance of the care-process variables. Negative dental cooperation was associated with sedation and/or general anesthesia, which is clinically plausible because pharmacologic behavior management is considered when conventional behavior guidance is insufficient [1, 24]. Unplanned loss to follow-up was associated with restorative treatment in both unadjusted and adjusted analyses, suggesting that unstable attendance is

associated with greater operative treatment burden. However, the association between unplanned loss to follow-up and sedation and/or general anesthesia was attenuated after adjustment, indicating that this relationship may be partly explained by age, medical complexity, caries-related visit reason, or geographic access factors. Similarly, multiple cooperation/visit-pattern difficulties remained associated with sedation and/or general anesthesia and restorative treatment after adjustment, but not with pulp therapy, suggesting that some treatment outcomes are more strongly influenced by disease-related factors than by care-process difficulty alone.

Caries-related visit reason showed strong associations with pulp therapy, restorative treatment, and sedation and/or general anesthesia, emphasizing that dental disease remains a major clinical determinant of operative treatment [25]. This distinction is important. The present findings do not suggest that parental depressive symptoms directly determine whether a child requires dental treatment. Rather, parental depressive symptoms may be relevant because they are associated with care-navigation difficulties that can complicate the timely and continuous delivery of necessary treatment. In children with caries-related needs, negative cooperation or unstable attendance may increase the likelihood that treatment becomes more difficult to complete, potentially requiring more intensive behavior management or staged operative care.

The timing of BDI assessment and outcome ascertainment improves the temporal interpretability but does not establish causality. By including only BDI assessments completed at the first dental visit or within 3 months before initiation of active dental treatment, and by counting dental treatment outcomes only at or after the eligible BDI assessment within the indexed episode, this study attempted to capture parental depressive symptoms near the start of care and reduce the possibility that BDI scores reflected treatment already delivered. This approach reduces, but does not eliminate, the possibility that BDI scores reflect parental reactions to anticipated or ongoing dental treatment burden [26].

The clinical implication is not that pediatric dentists should diagnose parental depression or assume that depressive symptoms cause poor dental outcomes. Rather, elevated maternal BDI may serve as a potential marker of families who could benefit from additional support during pediatric dental care, particularly in hospital-based or medically complex settings. When maternal depressive symptoms or overt caregiver distress are recognized, dentists may consider adapting patient management by using structured appointment planning, implementing reminder and follow-up systems to reduce missed or rescheduled visits, and introducing early behavior guidance for the child. Treatment plans can be communicated as clear, manageable steps to reduce cognitive and emotional burden on caregivers, and coordination with pediatric medical teams can help align dental visits with broader medical care. When significant caregiver distress appears to interfere with care navigation, appropriate psychosocial or mental health support may be warranted. Such strategies are consistent with a family-centered approach to pediatric dentistry and illustrate how maternal depressive symptoms can function as a family-level psychosocial marker that prompts additional appointment-navigation support, behavior guidance, and multidisciplinary collaboration.

This study has several limitations. First, it was conducted at a single tertiary pediatric dental center, and the study population included a substantial proportion of medically complex children; therefore, the findings may not be generalizable to community dental settings. In such settings, parental depressive symptoms may manifest differently, and the balance between caries-related disease burden and care-process difficulties could vary. Multicenter studies spanning hospital-based and community practices will be necessary to determine the generalizability of these findings across different pediatric dental settings. Second, BDI is a self-report symptom measure and should not be interpreted as a diagnosis of depressive disorder. Third, although BDI timing and outcome ascertainment were predefined in relation to the indexed dental care episode, the retrospective design precludes causal inference. Fourth, residual confounding cannot be excluded. Although selected associations were examined using adjusted logistic regression, the dataset did not fully capture important potential confounders, including caries severity, oral hygiene, diet, caregiver availability, previous dental experience, provider-level decision-making, or detailed socioeconomic status. Fifth, paternal BDI data were less complete than maternal data, limiting the ability to evaluate paternal associations. Sixth, we did not construct fully adjusted logistic regression for all potential covariates, and for outcomes with few events, the number of adjustment variables was deliberately restricted to avoid overfitting. Therefore, the adjusted maternal BDI associations presented in **Supplementary Table 1** should be interpreted as sensitivity analyses that account for selected potential confounders rather than definitive causal effects. Finally, multiple comparisons were performed; therefore, the findings should be interpreted as clinically informative observational associations that require confirmation in prospective studies.

Despite these limitations, this study has several strengths. Maternal and paternal depressive symptoms were evaluated separately, BDI assessments were temporally linked to the initiation of pediatric dental care, and care-process variables were distinguished from treatment outcomes. The study also integrated cooperation, visit pattern, referral characteristics, and treatment burden into a clinically interpretable framework. This approach reduces the risk of overinterpreting parental depressive symptoms as a direct cause of dental treatment while highlighting their potential value as a family psychosocial marker for identifying children and caregivers who may need additional care-navigation and supportive strategies.

5. Conclusions

Maternal BDI $\geq$20 was associated with several indicators of dental care-process difficulty, including missed or rescheduled visits, unplanned loss to follow-up, examination-oriented visits, and referral from pediatrics. An association with negative dental cooperation was observed in unadjusted analysis, although this relationship became non-significant after adjustment for age, disability or rare disease, residence, sex, and caries-related visit reason, suggesting that child age and medical complexity are primary drivers of cooperation problems. Paternal BDI $\geq$20 was not significantly associated with

these care-process variables. Neither maternal nor paternal BDI status was directly associated with dental treatment outcomes, including preventive care, restorative treatment, pulp treatment, extraction, sedation, or treatment under general anesthesia.

Cooperation and visit-pattern difficulties were associated with pharmacologic behavior management and operative treatment burden, supporting a conceptual model in which parental depressive symptoms are more closely related to how pediatric dental care is accessed, maintained, and completed than to the need for operative treatment itself. In this context, elevated maternal BDI may serve as a family-level psychosocial marker for identifying children and caregivers who could benefit from structured appointment planning, early behavior guidance, simplified communication of treatment sequencing, reminder and follow-up systems, coordination with pediatric medical teams, and referral to psychosocial or mental health services when caregiver distress is evident.

Future research should build on these observational findings using prospective, multicenter designs that recruit families across tertiary hospitals and general pediatric dental practices. Longitudinal assessment of caregiver mental health, including depressive symptoms, anxiety, parenting stress, resilience, and socioeconomic factors, will be essential to clarify temporal relationships and potential causal pathways. Such studies could determine whether targeted support for caregivers with elevated depressive symptoms is associated with improvements in appointment adherence, child cooperation, and long-term dental outcomes, and could inform evidence-based guidelines for integrating family psychosocial assessment and supportive care strategies into pediatric dental care.

ABBREVIATIONS

BDI, Beck Depression Inventory; CI, confidence interval; OR, odds ratio; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analyzed during the current study are not publicly available due to institutional privacy and ethical restrictions but are available from the corresponding author upon reasonable request and with appropriate institutional approval.

AUTHOR CONTRIBUTIONS

CMK and JL—designed the research study. YSC and CMK—performed the research and analyzed the data; wrote the manuscript. JL, KEL, JSS, HJC and JHL—provided help and advice on data analysis and interpretation. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Institutional Review Board of Yonsei University Dental Hospital (IRB Approval No. 2-2025-0060), and the requirement for informed consent was waived because of the retrospective design. All collected data were anonymized before analysis.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. Chung-Min Kang is member of the Editorial Board of this journal. We declare that Chung-Min Kang had no involvement in the peer review of this article and did not have access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to BB.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jocpd.com/files/article/211750509749775564 8/attachment/Supplementary%20material.docx.

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